(12) UK Patent Application (19) GB (11) 2 237 227 (13) A

(43) Date of A publication 01.05.1991

(21) Application No 9019260.0

(22) Date of filing 04.09.1990

(30) Priority data
(31) 01227601 (32) 04.09.1989 (33) JP

(71) Applicant
Nisshin Seiko Kabushiki Kaisha

(Incorporated in Japan)

No. 4-1 Marunouchi 3-chome, Chiyoda-ku, Tokyo, Japan

(72) Inventors
Jun Kurobe
Kenji Hara
Masayuki Ishihara

(74) Agent and/or Address for Service
Marks & Clerk
57-60 Lincoln's Inn Fields, London, WC2A 3LS, United Kingdom

(51) INT CL[5]
B21B 1/38

(52) UK CL (Edition K)
B3M ME M10C M17A4 M19B M19D M24 M3X M9K M9Q M9T
U1S S2066 S2067

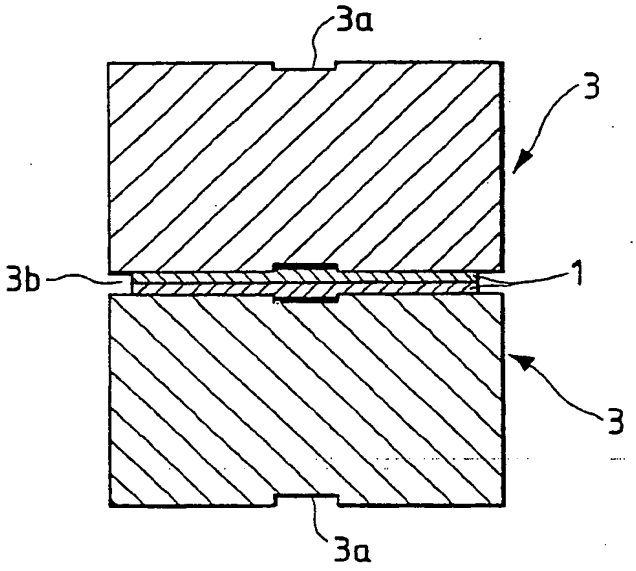
(56) Documents cited
GB 1287005 A

(58) Field of search
UK CL (Edition K) B3M ME MFB MG MN
INT CL[5] B21B, B21H

(54) Rolling metal plates

(57) A method of cold-rolling metal plates 1 between work rolls 3 wherein at least one of the work rolls has a barrel provided with a circumferential groove 3a. A plurality of metal plates 1 overlaid one upon another are rolled together between the work rolls 3 to a reduction ratio of 30% or lower in one feeding operation, and the resulting sectionally deformed metal plates 2 are then separated from each other.

FIG. 2



GB 2 237 227 A

FIG. 1

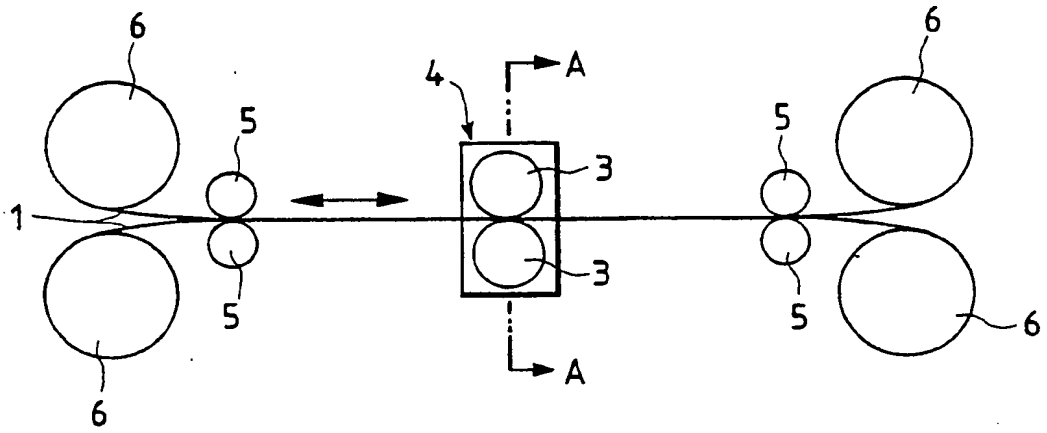


FIG. 2

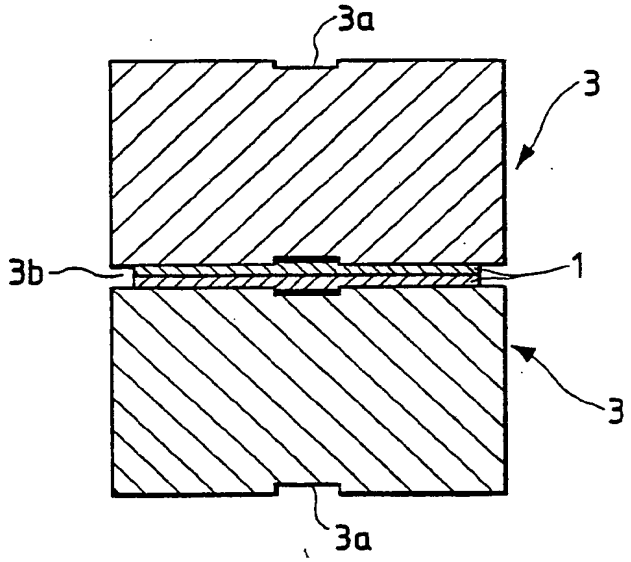


FIG. 3

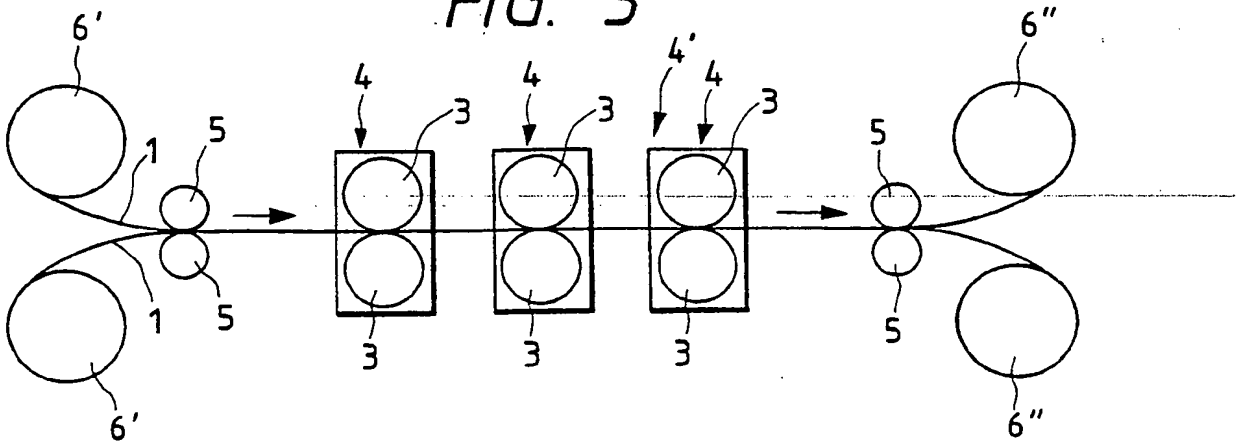


FIG. 4

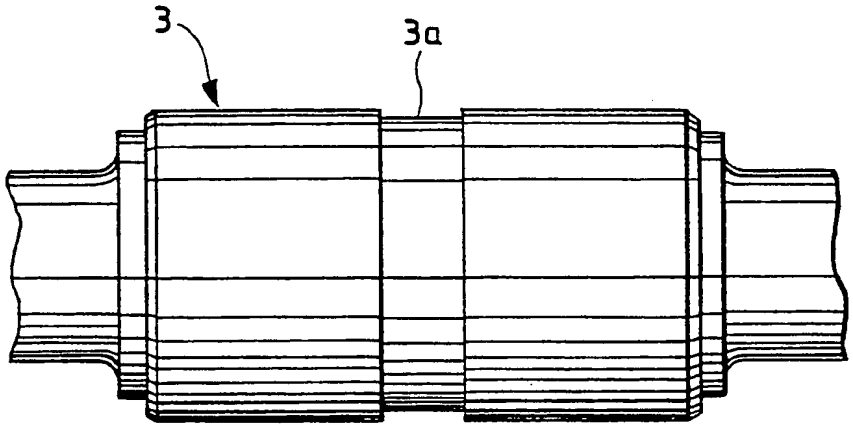

3
3a

FIG. 5

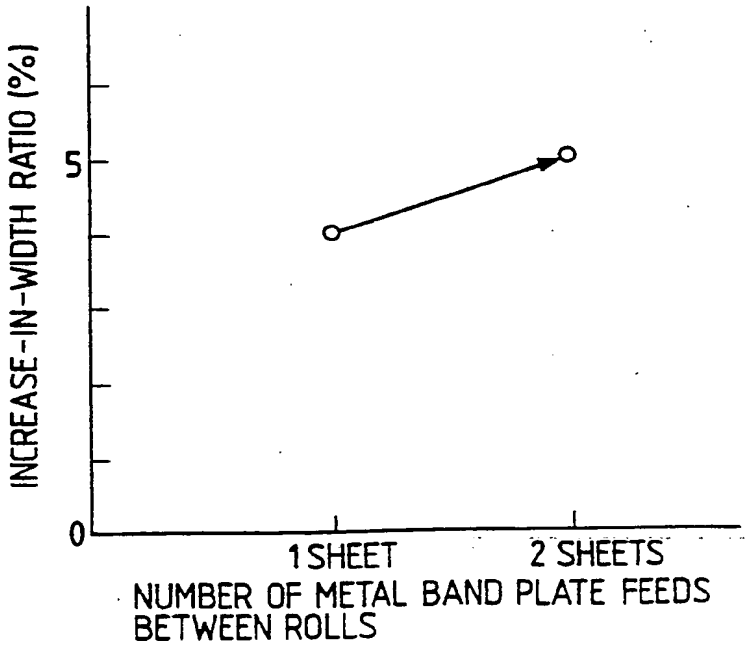

INCREASE-IN-WIDTH RATIO (%)
5
0
1 SHEET
2 SHEETS
NUMBER OF METAL BAND PLATE FEEDS BETWEEN ROLLS

FIG. 6

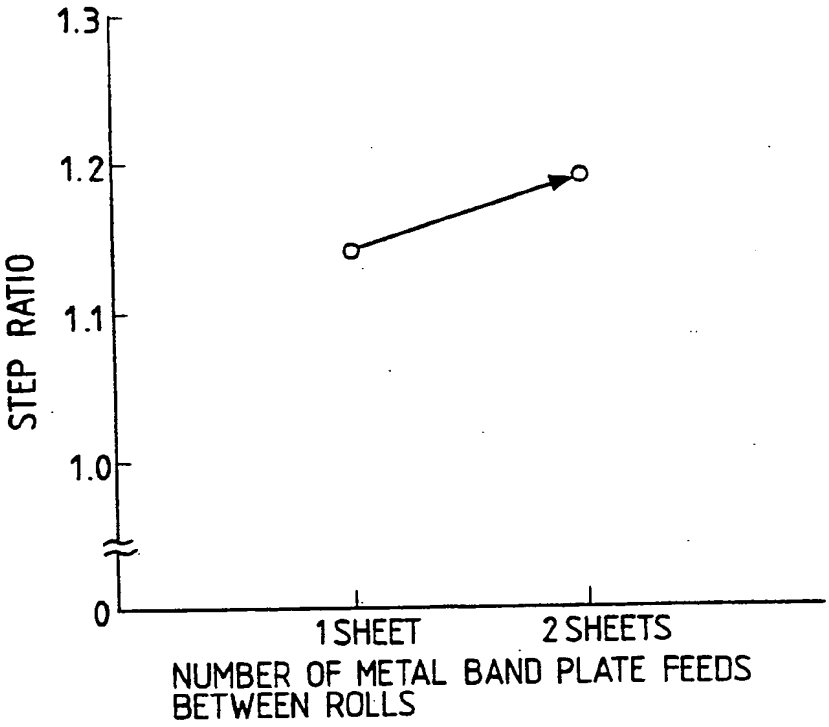
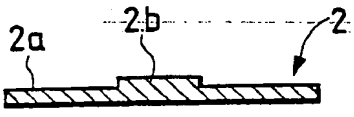

1.3
1.2
1.1
1.0
0
STEP RATIO
1 SHEET
2 SHEETS
NUMBER OF METAL BAND PLATE FEEDS BETWEEN ROLLS

FIG. 7


2a
2b
2

METHOD FOR MAKING BAND PLATES DEFORMED IN SECTION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method for making band plate feeds deformed in section, which vary stepwisely in thickness in their lateral direction, by cold rolling.

Prior Art

A sectionally deformed band plate feed 2 in which a metal plate feed 2a is stepped at 2b on one side, as illustrated in Figure 7 by way of example - hereinafter simply called a deformed band plate feed - finds use in many applications such as connectors' contactors, relays' contactors and terminals for lapping connection.

Hitherto, such deformed band plate feeds have been typically made by the following techniques.

(1) Cutting

A metal band plate feed of rectangular section is fed along its longitudinal direction, and is continuously cut in preselected, lateral positions by cutting or milling.

(2) Intermittent Rolling

As set forth in Japanese Patent Publication No. 53(1978)-27234, a metal band plate feed to be rolled is fed between a reciprocating flat roll and a mold provided on its side facing said flat roll with a projection or recess having a gradually increasing width; during this process a certain pressure is applied to the flat roll to form on the band plate feed steps following the surface geometry of the mold.

However, a problem with the above cutting technique is that swarf produced in cutting the metal band plate feed not only makes the working environment worse but also lowers the yield due to increased material losses. Another problem arises in connection with the quality of the products, since they have burrs, ridges, etc. on their cut ends. The intermittent rolling technique, on the other hand, is unsuitable for making a variety of deformed band plate feeds, since it needs expensive molds. Another drawback with this technique is that the production efficiency is very low, due to difficulties encountered in continuously making deformed band plate feeds.

In addition to the above techniques, there is another rolling technique in which one metal band plate feed to be rolled is fed between a pair of work rolls, at least one of which includes a barrel provided with a

circumferential groove, thereby producing a deformed band plate feed. According to this technique, however, the rolling process is effected with a pair of rollers of the same diameter and the work rolls rotate at the same speed, so that the metal band plate feeds are considerably elongated in the rolling direction. There is thus a large difference in length in the rolling direction between the rolled and unrolled portions, giving rise to undulations on the rolled portion. Such undulations become more marked the higher the reduction ratio.

In view of such problems with the prior art as mentioned above, a primary object of the present invention is to provide a method for efficiently making satisfactory band plate feeds deformed in section, which can be practised with an improved yield but without causing swarf, burrs or undulations.

SUMMARY OF THE INVENTION

As a result of studies made to solve the above problems, it has been found that the best method for improving yield and production efficiency is cold rolling in which metal band plate feeds are fed between opposing work rolls, and that a large difference in length along the rolling direction between the unrolled and rolled portions is caused by the fact that the feeds are only slightly deformed in the direction perpendicular to the rolling direction. Further, it has

been found that if a plurality of metal band plate feeds with substantially equal resistance to deformation, while overlaid one upon another, are cold-rolled between work rolls to a reduction ratio of 30% or lower in one feeding operation, then it is possible to increase the frictional forces acting on the sides of the metal band plate feeds opposite to the sides engaging the work rolls, so that their elongation in the rolling direction can be limited, whilst allowing their lateral deformation to take place. This has led to another finding, namely that sectionally deformed thin band plate feeds can be made while causing neither undulations on, nor cladding of, said plate feeds.

According to the present invention, there is provided a method for making sectionally deformed band plate feeds by cold-rolling metal band plate feeds between work rolls, wherein at least one of said work rolls has a barrel provided with a circumferential groove; a plurality of metal band plate feeds with substantially equal resistance to deformation, while overlaid one upon another, are rolled together between said work rolls to a reduction ratio of 30% or lower in one feeding operation and the resulting metal band plate feeds are separated from each other.

BRIEF DESCRIPTION OF THE DRAWINGS

The method for making sectionally deformed band plate feeds deformed in accordance with the present

invention will now be described, by way of example, with reference to the accompanying drawings in which: -

Figure 1 is a schematic view illustrating one embodiment of carrying out the method of the present invention,

Figure 2 is an enlarged part end view taken along the line A-A of Figure 1,

Figure 3 is a schematic view illustrating another embodiment of carrying out the method of the present invention,

Figure 4 is an enlarged front view showing one example of a work roll in engagement with a metal band plate feed to be rolled,

Figure 5 is a graph showing an increase-in-width ratio obtained when one pure-copper band plate feed is rolled alone and with another one overlaid on it,

Figure 6 is a graph showing a step ratio obtained when one pure-copper band plate feed is rolled alone and with another one overlaid on it, and

Figure 7 shows, by way of example, the section of a typical deformed band plate feed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to carry out the method of the present invention, a rolling stand 4 is provided, which includes a pair of opposing work rolls 3 at positions where a metal band plate feed 1 is located between the work rolls on both sides. A gap 3b between the work rolls 3

housed within the rolling stand 4 is such that the reduction ratio of the band plate feed 1 rolled between said work rolls in one operation is 30% or less. At least one of the work rolls 3 must include a barrel provided with a circumferential groove 3a. The other roll 3 may preferably be provided with a groove 3a of the same width at a position corresponding to that of the groove 3a of the one work roll 3. Alternatively, a flat work roll without a groove on the barrel may be used.

One metal band plate feed 1 overlaid with one or more metal band plate feeds 1 is fed between the work rolls 3 housed within the rolling stand 4. The metal band plate feeds 1 are preferably of the same material. However, different materials with substantially equal resistance to deformation may be rolled together.

If the final reduction ratio is 30% or less, in making the deformed band plate feeds 2, a plurality of the metal band plate feeds 1, overlaid one upon another, may then be rolled between a set of the opposing work rolls 3 in one feeding or passing operation. If the final reduction ratio exceeds 30%, on the other hand, use may then be made of a reverse rolling technique in which, as illustrated in Figure 1, pay-off and take-up reels 6 are provided with the number of pairs corresponding to the number of the metal band plate feeds 1 put one upon another and are provided on both

sides of one rolling stand 4 beyond two pairs of deflector rolls 5, respectively. The metal band plate feeds 1 are fed from one pair of pay-off and take-up reels 6 through the associated pair of deflector rolls 5 between the work rolls 3 housed in the rolling stand 4, from which they are fed onto the other pair of pay-off and take-up reels 6 through the associated pair of deflector rolls 5. After the gap 3b shown in Figure 2 between the work rolls 3 housed in the rolling stand 4 is reduced, the metal band plate feeds 1 are then rolled back between the work rolls 3. This operation is repeated, as desired. Alternatively, the reduction ratio may be regulated to 30% or lower for one feeding operation between the work rolls 3 of a tandem-rolling operation. As illustrated in Figure 3 pay-off reels 6' and take-up reels 6" are provided with the number of pairs corresponding to the number of the metal band plate feeds 1 and are provided on both sides of a rolling stand group 4' comprising a plurality of rolling stands 4, each housing a pair of work rolls 3, beyond two pairs of deflector rolls 5. Gaps, shown at 3b in Figure 2, between the respective pairs of work rolls 3 are designed to narrow gradually in the direction shown by an arrow. The metal band plate feeds 1 are fed from a pair of pay-off reels 6' located on the side of the rolling stand 4 housing a pair of work rolls 3 having the largest gap 3b through the associated pair of

deflector rolls 5 into the rolling stand group 4', from which they are in turn fed onto the pair of take-up reels 6" through the associated pair of deflector rolls 5.

In this manner, a plurality of the metal band plate feeds 1 to be rolled are rolled between the work rolls 3 to a given size. Thereafter, the metal band plate feeds 1 overlaid one upon another are taken up by either one of the pairs of pay-off and take-up reels 6 or take-up reels 6" to separate the metal band plate feeds from each other, as shown in Figure 1 or 3.

According to the method of the present invention, a plurality of flat metal band plate feeds 1 are rolled together between a pair of work rolls 3 having their barrels each provided with a circumferential groove 3a. The metal band plate feeds 1 first engage the portions of the work rolls 3 in which no grooves 3a are present, whereby only those portions are rolled. Thus, steps are formed on the metal band plate feeds 1 accordingly, thereby making the deformed band plate feeds 2 having thickness steps in their lateral direction. Since large frictional forces act between the metal band plate feeds 1 during the rolling process, the component of such forces in the rolling direction places some limitation on the elongation of the portions, to be rolled, of the metal band plate feeds which tend to be rolled in the rolling direction, so that they are deformed mainly in

their lateral direction.

Further, since the metal band plate feeds 1 are rolled together between a set of the opposing work rolls 3 to a reduction ratio of 30% or lower in one feeding operation, they are unlikely to become clad that is, adhered together even when they are rolled while overlaid one upon another.

Example

While overlaid one upon another, two pure-copper band plate feeds, each 3 mm in thickness and 30 mm in width, were rolled together between a set of opposing work rolls having a diameter of 70 mm and a length of barrel of 120 mm, one having a barrel provided with a 18-mm wide and 1-mm deep groove in its axial center and the other being a flat work roll, to a reduction ratio of 20% at a peripheral speed of 4.5 m/min. in one feeding operation, without using any rolling oil. For the purpose of comparison, a single pure-copper band plate feed of the same dimensions was rolled under the same conditions as described above. As a result, it turned out that the band plate feeds rolled according to the present invention gave higher values both for the ratio of an increase-in-width (see Figure 5) and the step ratio or the ratio of the thickness of unrolled portions to the thickness of rolled portions (see Figure 6) than the band plate feeds rolled as a comparative example.

As detailed above, the present invention provides a

method for efficiently making improved band plate feeds deformed in section, with improved yields but without producing swarf or causing burrs and undulations, thereby making it possible to use sectionally deformed band plate feeds in many applications, and so is of great industrial value, as will be appreciated from its advantages as set out below.

(1) The metal band plate feeds are laterally stepped by rolling. Thus, not only can they be produced without waste and so with an improved yield, but they can also be continuously rolled by opposing work rolls at a certain speed with improved productivity.

(2) As large frictional forces act in the rolling direction of the metal band plate feeds, some limitation is placed upon their elongation in their rolling direction, so that they can be deformed mainly in their lateral direction with no difference in rolling length between the unrolled and rolled portions. It is thus possible to make sectionally deformed band plate feeds of high quality without causing undulations.

(3) If the metal band plate feeds are reciprocated through a single rolling stand, then they can be rolled using one set of work rolls, even when the final reduction ratio of the sectionally deformed band plate feed to be made exceeds 30%. Further, if provision is made for an arrangement of a plurality of rolling stands in which the gaps between sets of work rolls are

designed to narrow gradually in a rolling direction, it is then possible to make sectionally deformed band plate feeds of a given dimension in one feeding operation in one direction with improved production efficiency.

(4) Since a plurality of metal band plate feeds are rolled together between a set of work rolls at a reduction ratio of 30% or lower in one feeding operation, they are unlikely to become clad that is, adhered together even when they are rolled while overlaid one upon another. Thus, they can be separated and coiled by pay-off and take-up reels or take-up reels with improved productivity.

(5) The use of a rolling stand housing a pair of opposing work rolls having their barrels provided with grooves of the same shape makes it possible to make two sectionally deformed band plate feeds at the same time, hence doubling productivity.

(6) Since the grooves in the work rolls can be formed easily and inexpensively and the attachment of said rolls to the rolling stand can be effected easily, it is possible to change the work rolls, and thus cheaply obtain a variety of sectional forms.

CLAIMS

1. A method for making sectionally deformed band plate feeds by cold-rolling metal band plate feeds (1) between work rolls (3), wherein at least one of said work rolls (3) has a barrel provided with a circumferential groove (3a), a plurality of metal band plate feeds (1) with substantially equal resistance to deformation, while overlaid one upon another, are rolled together between said work rolls (3) to a reduction ratio of 30% or lower in one feeding operation and the resulting metal band plate feeds (1) are separated from each other.

2. A method as claimed in Claim 1, wherein said metal band plate feeds (1) are reciprocated through a set of said work rolls (3) and a gap (3b) between said work rolls (3) is reduced whenever said plate feeds (1) are rolled back.

3. A method as claimed in Claim 1, wherein said metal band plate feeds (1) are fed in one direction through an arrangement of a plurality of sets of work rolls (3) with the gaps (3b) between them being designed to narrow gradually in the feeding direction of said metal band plate feeds (1).

4. A method as claimed in any one of Claims 1-3, wherein said work roll (3) opposite to said work roll

(3) having said groove (3a) is provided with a groove (3a) which is in a position corresponding to the former groove (3a) being the same width as the width of the former groove (3a).

5. A method as claimed in any one of Claims 1-3, wherein said work roll (3) opposite to said work roll (3) having said groove (3a) is a flat work roll having no groove in its barrel.

Published 1991 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.